

MOUNTAIN RUN PCB

STUDY

JOSEPH G. WALLMEYER

BIOLOGIST

VIRGINIA STATE WATER CONTROL BOARD

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PREFACE

Polychlorinated Biphenyls (PCB's) are a widely used group of very stable, highly persistent toxic compounds. Because of this, the Food and Drug Administration (FDA) is taking steps to limit the ways in which PCBs may contaminate food and to limit the otherwise unavoidable levels of PCB residues in food.

The Federal Register of 18 March 1972, 37 FR 5705, contains the Food and Drug Administration's Notice of Proposed Rule Making in regard to Polychlorinated Biphenyls. In this, the FDA proposes a 5.0 part per million temporary tolerance limit for the edible portion of fish. Even prior to this, the Virginia State Water Control Board initiated studies into the PCB levels in several river basins.

This report is concerned with the PCB contamination of water, sediment, and fish in a small stream in north-central Virginia.

ABSTRACT

Wallmeyer, Joseph G. (Virginia State Water Control Board, Richmond, Virginia) Mountain Run PCB Study. Unpublished, 1972.

Following identification of the Culpeper Sewage Treatment Plant as an agent for the dispersal of PCB (Polychlorinated Biphenyl) into Mountain Run, fish and sediment were sampled to ascertain the level of contamination. Some of the fish from Mountain Run and part of the Rappahannock River proved to contain levels of the chlorinated hydrocarbon in excess of the FDA 5.0 ppm guideline. The extent of contamination was directly related to the proximity to the Sewage Treatment Plant effluent. The source of PCB into the municipal sewage system was found to be a rental uniform service.

MOUNTAIN RUN PCB STUDY

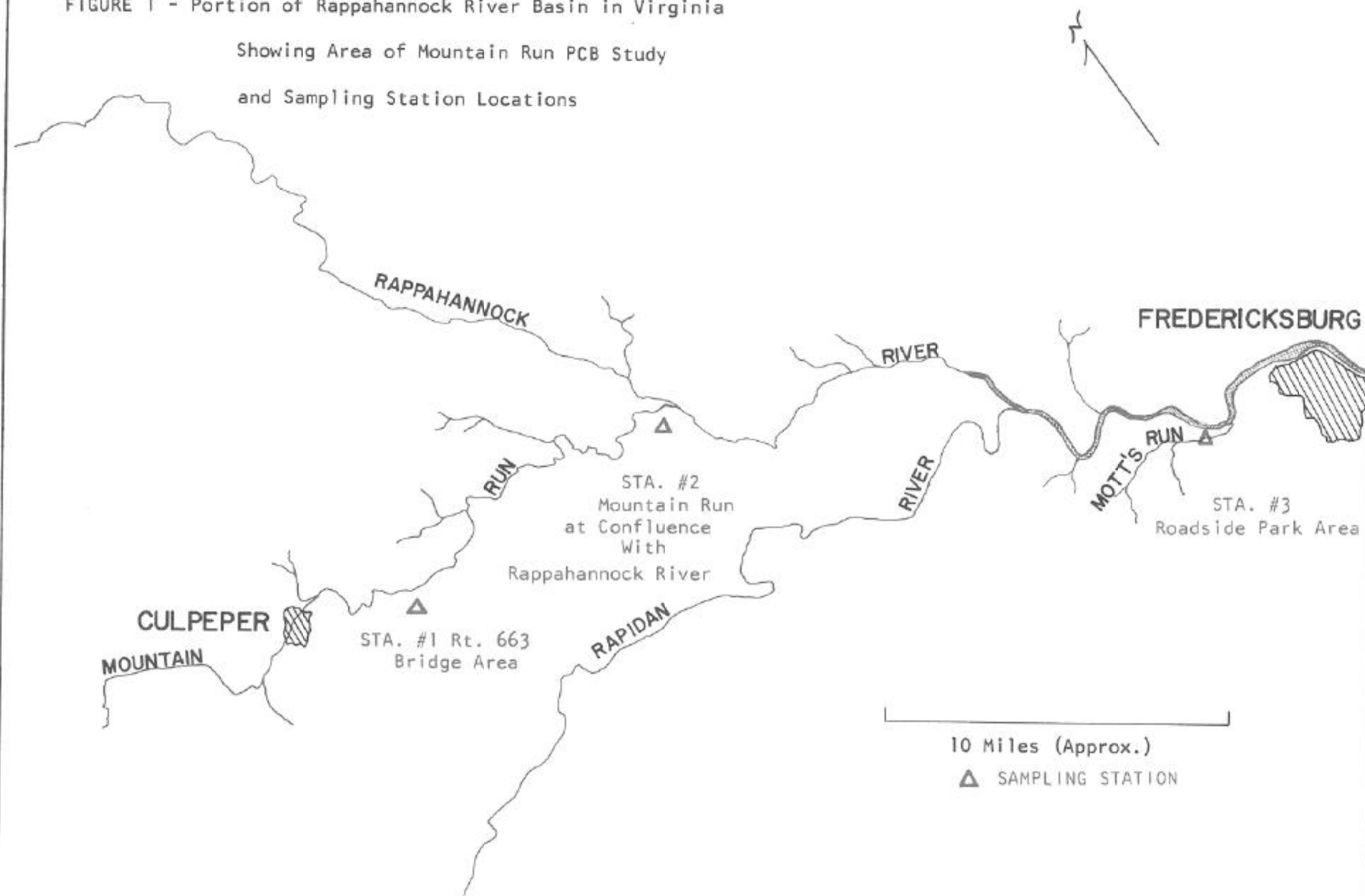
Introduction

In the last few years the family of compounds known as Polychlorinated Biphenyls (PCBs) has come to the attention of environmentalists as another widespread contaminant. This investigation was launched after routine pesticide monitoring showed high levels of the chlorinated hydrocarbon being discharged from the Sewage Treatment Plant (STP) owned and operated by Culpeper, Virginia. Subsequent sampling of the plant effluent indicated that this was a chronic discharge and not a onetime 'slug' passing through the STP. This study was directed at ascertaining the PCB levels in the fish and sediment in Mountain Run below the STP and part of the Rappahannock River below the confluence with Mountain Run.

Mountain Run, with its headwaters near the Bruce Mountain area of Culpeper County, flows west to east through the Piedmont Province of Virginia for 32 miles before joining the Rappahannock River about 25 miles west of Fredericksburg. The drainage area of Mountain Run consists primarily of rich farm lands and deciduous forest (See Figure 1). The main community within the drainage area, Culpeper, is not heavily industrialized. Water quality is generally good although organic degradation by STP wastes is present in some areas.

FIGURE 1 - Portion of Rappahannock River Basin in Virginia

Showing Area of Mountain Run PCB Study
and Sampling Station Locations



Chemistry and Biology of PCB

PCBs are produced in this country by the Monsanto Company, and overseas by several manufacturers. Monsanto produces PCBs under the trade name Aroclor with a four number suffix, such as Aroclor 1254. The 12--designates that the compound is a pure biphenyl (as opposed to a terphenyl or a blend of biphenyls and terphenyls) and the -- 54 designates the weight per cent chlorine (Peakall and Lincer, 1970).

PCBs are generally considered to be chemically inert, insoluble in water, and very soluble in hydrocarbon solvents. PCBs are widely used; among other things, they have been used as plasticizers, sealing compounds, fungicidal insulations, dielectrics, heat transfer media, carriers of pesticides, and higher temperature high-pressure lubricants. (Veith and Lee, 1970).

The PCBs are similar to DDT in that they are both chlorinated hydrocarbons and have been shown to be subject to biological magnification. Work done by Keil et. al. (1971) has shown the ability of *Cylindrotheca closterium*, a marine diatom, to concentrate PCB up to 1100 times the concentration added to the culture medium. Stalling (1971), working with bluegills and channel catfish, was able to show concentration factors ranging from 26,500 to 52,000 in an 11-week test exposure to Aroclor 1248 and 1254 ranging from 6-14 ug/l.

Duke, (1971) subjected juvenile pinfish, *Lagodon rhomboides*, and adult mosquitofish, *Gambusia affinis*, to acute toxicity tests using Aroclor 1254. In the 48 - hr. period, pinfish survived up to 100 parts per billion (ppb) and the mosquito fish up to 10,000 ppb. But in chronic toxicity tests of the pinfish and ocean spot, *Leiostromous xanthurus*, exposure to 5.0 ppb for 14-45 days was fatal.

The literature indicates that little is known of the biodegradation of PCBs or their effects on humans, but Peakall and Lincer (1970) state that it appears that the lower vertebrates and invertebrates are less susceptible than mammals to direct toxicity from PCBs.

As with DDT, the Food and Drug Administration has set a 5.0 parts per million (ppm) guideline on PCB in edible tissue of fish shipped in interstate commerce.

METHODOLOGY

Samples collected in this investigation included water, sediment, fish, and a piece of cloth taken from a new work uniform. Chemical analysis were performed by the Residue Lab of the Virginia Department of Agriculture and Commerce using gas chromatography with micro-coulometric detection.

Water samples consisted of 2 - ½ gallon Mason jars filled to overflowing. The sediment samples (collected at only 1 station) consisted of the top three inches of mud by 1 inch increments. Two cores of mud were taken using cylindrical sampling tubes. The cores were frozen in dry ice, cut into 1 inch increments, composited, and taken to the Residue Lab for analysis.

Fish collections were made using both hook and line and shocking (electro-fishing) equipment. Prior to shipment to the Residue Lab the fish were "cleaned" similar to that which is done in preparing fish for the frying pan, i.e., the head, scales, fins, and visceral material were removed. The sample therefore consisted of edible meat and part of the axial skeleton. Each fish sample was macerated in a commercial-type meat grinder prior to solvent extraction.

The common names of fish are used throughout this report because of their familiarity and general acceptance by the public, but for reference purposes the scientific names are listed below.

bluegill	<i>Lepomis macrochirus</i>
pumpkinseed	<i>Lepomis gibbosus</i>
redbreast sunfish	<i>Lepomis auritus</i>
white sucker	<i>Catostomus commersoni</i>
shorthead redhorse	<i>Macrolepidotum</i>
smallmouth bass	<i>Micropterus dolomieu</i>
black crappie	<i>Poxomis nigromaculatus</i>

The sample of cloth submitted for analysis was from a new uniform. There was no special sample preparation for this sample; it was merely subjected to solvent extraction and extract concentration similar to that which is done for water samples.

Results

Water

Following the identification of Culpeper Sewage Treatment Plant (STP) as an agent for the discharges of PCB through routine monitoring earlier in 1971, water samples were collected from the sewer lines leading to the STP in order to determine the source of PCB. Using this method it was learned that the PCB was being discharged from a uniform rental service operation (see Table 1).

Table 1. Result of samples collected to determine the source of PCB

Date	Sample	Value	Archlor
10/71	Culpeper - manhole on line 1	none detected	
10/71	Culpeper - manhole on line 2	none detected	
10/71	Culpeper - manhole on line 3	none detected	
10/71	Culpeper - manhole on line 4	none detected	
10/71	Culpeper - manhole on line 5	5.0 ug/l	1254
10/71	Culpeper - STP influent	15 ug/l	1254
10/71	Culpeper - STP effluent	13 ug/l	1254

Following identification of line 5 as being the one containing the PCB, samples were collected from the only uphill industrial discharge, a rental uniform operation. The samples taken in December 1971 were of the liquid final effluent and a piece of cloth from a new uniform. The effluent contained 350 ug/l of Aroclor 1254, while the uniform contained 0.3 ppm of Aroclor 1248. It should be noted that while the sample of cloth did show PCB at a level roughly equivalent to that of the rental service effluent that these samples contained different types of Aroclors.

Fish

In October 1971, 6 fish were taken from Mountain Run, the stream receiving the STP effluent, at a point located about 10 miles downstream from the STP. The purpose of these samples was to

determine the extent to which the contaminant had been concentrated in fish (see Table 2).

Table 2. Fish Tissue Samples - Mountain Run, Rt. 633 Bridge Area (Station 1, Oct. 1971)

Fish	Value Arocolor 1254
Pumpkinseed	28 ppm
Pumpkinseed	22 ppm
Pumpkinseed	11 ppm
Bluegill	11.5 ppm
Bluegill	56.0 ppm
Bluegill	4.3 ppm

Five out of 6 (83%) fish collected at Station 1 greatly exceeded the 5.0 ppm PCB in edible tissue guideline set by the FDA. The average for the station was 22.1 ppm PCB with bluegills averaging 23.9 ppm and pumpkinseed averaging 20.3 ppm.

Following the results of the October samplings additional fish samples were taken in January 1972, from Mountain Run at its confluence with the Rappahannock River (Station 2) and again about 20 miles further down the Rappahannock River at Roadside Park just above the confluence with Motts Run (Station 3), (see Tables 3 & 4).

Table 3. Fish Tissue Samples - Mountain Run at Confluence with Rappahannock River (Station 2, January 1972)

Fish	Value (Aroclor 1242)	Value (Aroclor 1254)	Total
White sucker	0.10 ppm	0.46 ppm	0.56 ppm
White sucker	0.08 ppm	0.89 ppm	0.97 ppm
White sucker	0.20 ppm	0.31 ppm	0.51 ppm
White sucker	0.25 ppm	1.8 ppm	2.05 ppm
White sucker	0.14 ppm	0.61 ppm	0.75 ppm
Redhorse sucker	0.29 ppm	4.3 ppm	4.59 ppm
Redhorse sucker	-	0.84 ppm	0.84 ppm
Redhorse sucker	-	7. ppm	7. ppm
Redhorse sucker	-	0.36 ppm	0.36 ppm
Redhorse sucker	-	4.7 ppm	4.7 ppm
Redbreast sunfish	-	4.6 ppm	4.6 ppm
Smallmouth bass	0.38 ppm	47.0 ppm	47.28 ppm

Only 2 out of 12 (17%) of the samples from Station 2 exceeded the FDA guideline while 3 additional fish samples approached the 5.0 ppm level. In these samples the Aroclor 1254 was found in every case and 7 out of 12 (58%) samples also showed 1242.

The overall average for this station was 6.2 ppm PCB in the fish tissue samples with levels for smallmouth bass and redbreast sunfish (1 sample each only) being 47.28 and 4.6 ppm respectively. The redhorse suckers average 3.5 ppm, while the white suckers averaged 0.97 ppm.

Table 4. Fish Tissue Samples - Rappahannock River at Roadside Park Area (Station 3, January 1972)

Fish	Value (Aroclor 1242)	Value (Aroclor 1254)	Total (ppm)
Bluegill	0.11 ppm	1.1 ppm	1.21
Bluegill	-	0.5 ppm	0.5
Bluegill	0.32 ppm	0.06 ppm	0.38
Bluegill	-	2.5 ppm	2.5
Bluegill	0.05	0.67 ppm	0.72
Bluegill	-	0.85 ppm	0.85
Black crappie	-	6. ppm	6.
Black crappie	none detectable		
Black crappie	-	3.4 ppm	3.4
Black crappie	-	0.13	0.13
Black crappie	0.02 ppm	0.2 ppm	0.22
Redhorse sucker	0.08 ppm	0.3 ppm	0.38
Redhorse sucker	0.17	0.10 ppm	0.27
Redhorse sucker	-	1.1 ppm	1.1
Redhorse sucker	0.13 ppm	0.89 ppm	1.02
Redhorse sucker	0.18 ppm	0.64 ppm	0.82
Largemouth bass	-	0.15 ppm	0.15
Largemouth bass	-	0.4 ppm	0.4

Only 1 sample of the 18 (6%) taken from the station exceeded the FDA Guideline. The average for Station 3 dropped to 1.1 ppm in fish tissue. At this station the average for black crappies was 1.95 ppm, for bluegills 0.98 ppm, for redhorse suckers 0.72 ppm, and for largemouth bass 0.28 ppm. Two Aroclors (1242 and 1254) were found at this station with the 1254 again dominating.

Length-weight-PCB data of fish taken from Stations 2 and 3 are shown in Appendix A. Analysis of that data is not included in this report; however, this data is being compiled with results from other studies in hope that some significant trends will develop.

Sediment

Sediment samples were collected as previously described from Station 1 to examine the amount of PCB deposited in the streambed. The samples were collected from a pooled area just above the Rt. 633 Bridge. The sediment collected could be described as a fine-grain, loosely-packed black muck.

Table 3. Sediment Samples - Mountain Run, Rt. 663 Bridge Area (Station 1, Nov. 1971)

Sample	Value (Aroclor 1254)
Top inch	27 ppm
Second inch	26 ppm
Third inch	36 ppm

With the exception of 1 station located below a large plant utilizing PCBs in the manufacture of electrical transformers, these sediment values are higher than any other collected in Virginia by the State Water Control Board to date. All of the samples at Station 1 showed Aroclor 1254, the same as the STP effluent.

DISCUSSION

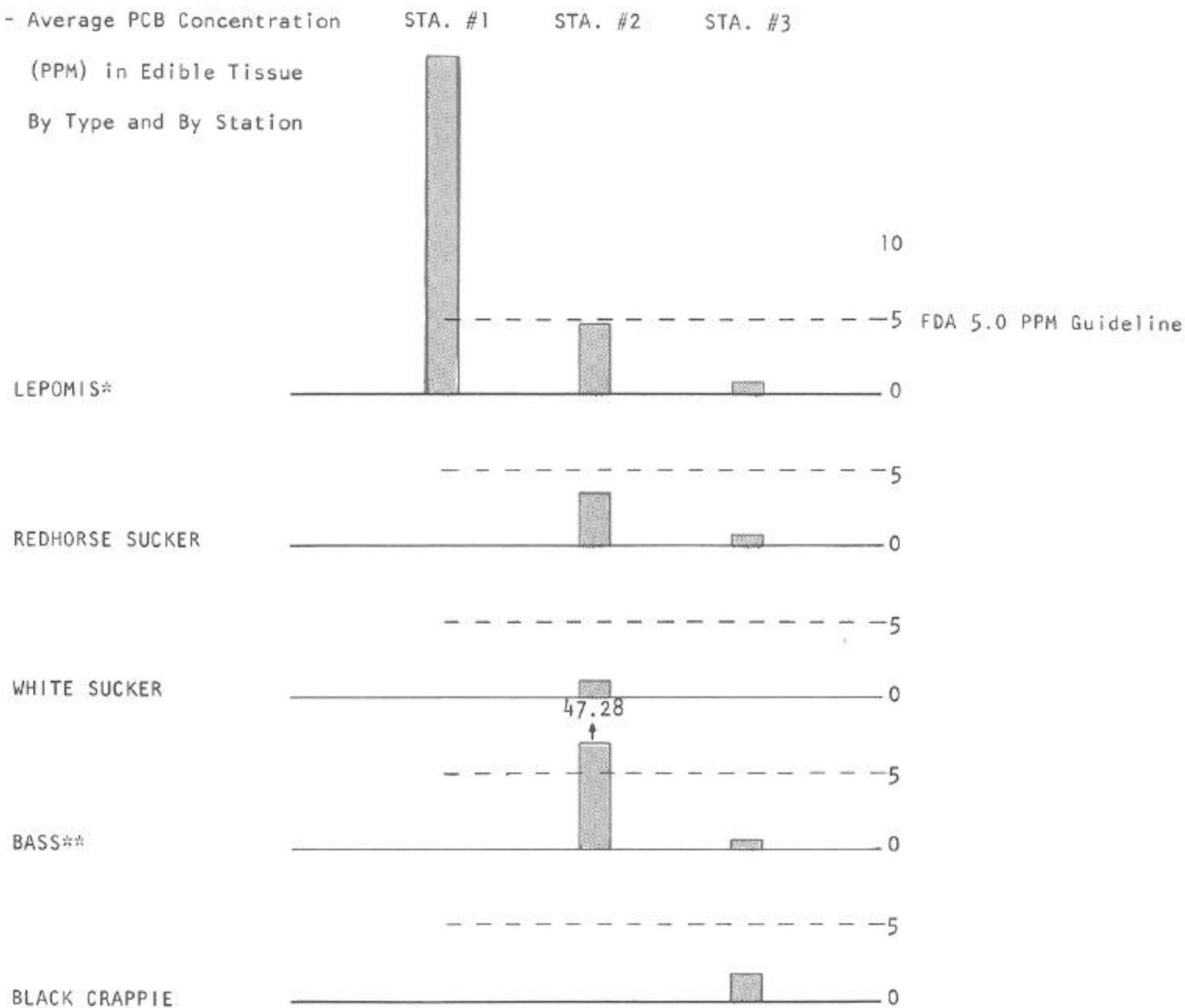
From the data presented it is observable that fish are concentrating PCBs to relatively high levels in part of the Rappahannock River Basin. Because of the small number of samples it is impossible to statistically compare the levels of PCB by fish species by station, but fish exceeding the 5.0 ppm FDA guideline were found at all stations sampled, with decreasing average levels encountered as one proceeds downstream from the Culpeper STP on Mountain Run and into the Rappahannock River (see Figure 2).

It is evident that Station 1 is grossly contaminated with PCB with an average of over 29 ppm in the 3 - one inch sediment samples. The average value for this station for 6 *Lepomis sp.* is 22.1 ppm, over 4 times the FDA guideline for edible tissue. Only 2 Centrarchids could be taken at Station 2; one a smallmouth bass containing over 47 ppm PCB and a redbreast sunfish just below the 5.0 ppm guideline. From this it would be expected that the average PCB level for the resident carnivorous fish population in Mountain Run would exceed the 5.0 ppm guideline.

Only a limited amount of insight can be drawn from the 10 suckers (redhorse & white suckers) taken from Station 2 because these fish are known to be migratory. But it is interesting to note that the average redhorse PCB level is over twice that for white suckers, and that all the white suckers contained both Aroclor 1242 and 1254 while only 1 of the 5 redhorse suckers contains Aroclor 1242.

Only 1 fish out of 18 at Station 3 was found to contain over 5.0 ppm PCB and none of the fish groups by species exceeds an average of 2 ppm. Thus, it appears that the effects of the PCB from

FIGURE 2 - Average PCB Concentration
(PPM) in Edible Tissue
By Type and By Station



* Includes Bluegill, Pumpkinseed, and Redbreast Sunfish

** Includes Largemouth and Smallmouth Bass

Mountain Run have diminished considerably at Station 3.

Because of the low solubility and high specific gravity of PCBs it is impossible to speculate just how long the hydrocarbon will be present in the aquatic system once the substance is eliminated from the effluent discharge. But because Station 1 is approximately 10 miles below the STP it is believed that the "peak" sediment PCB values are upstream from Station 1. This PCB in the sediment could be incorporated into the biota relatively quickly following resuspension, another factor to be considered when looking at the already high levels found in fish in Mountain Run.

Although most streams which receive effluents from sewage treatment plants are not generally noted for the fishery resources, that does not mean that it would be acceptable to forego warning the public of the potential health hazard of the utilization of any fish or water taken from Mountain Run below the town of Culpeper. Furthermore, Mountain Run should be kept under surveillance to note the status of PCB in the aquatic system.

Because it is not known from where in the uniform rental plant the PCB is coming, the door is open for more research to be conducted in this field. There is the possibility that a leaking heat transfer system using PCB could be the ultimate source, or that the cleaning fluid could contain PCB, or even that PCB is entering the plant via soiled work uniforms. Many questions are still unanswered. Through communication by the staff of the Water Control Board with the president of the company which runs the uniform rental service plant it was learned that there are 2 other similar plants in operation in Virginia and still more plants throughout the Southeastern United States. Samples of the effluents of the plants in Virginia indeed did reveal the presence of PCBs - the Richmond plant was discharging 42.7 ug/l (Aroclor 1232) and 70.7 ug/l (Aroclor 1254) while the Vinton plant was discharging 21.0 ug/l (Aroclor 1221).

Appendix A

Fish Length-Weight-PCB Data for Mountain Run PCB Study

STATION	FISH	LENGTH (ins.)	WEIGHT (gms)	PCB (ppm)
1	Length-Weight-PCB data not collected			
2	white sucker	10.0	257	0.56
	white sucker	9.5	182	0.97
	white sucker	11.5	274	0.51
	white sucker	12.5	359	2.05
	white sucker	10.5	218	0.75
	redhorse sucker	8.5	129	4.59
	redhorse sucker	9.0	156	0.84
	redhorse sucker	9.0	153	7.
	redhorse sucker	8.0	101	0.36
	redhorse sucker	9.0	160	4.7
	redbreast sunfish	7.0	130	4.6
	smallmouth bass	10.5	259	47.28
3	Bluegill	5.5	71	1.21
	Bluegill	5.5	59	0.5
	Bluegill	8.0	105	0.38
	Bluegill	5.5	53	2.5
	Bluegill	5.5	46	0.72
	Bluegill	6.5	94	0.85
	black crappie	8.0	110	6.
	black crappie	8.0	117	none detectable
	black crappie	7.0	90	3.4
	black crappie	7.0	85	0.13
	black crappie	7.5	101	0.22
	redhorse sucker	8.0	105	0.38
	redhorse sucker	10.0	232	0.27
	redhorse sucker	9.5	155	1.1
	redhorse sucker	9.0	146	1.02
	redhorse sucker	9.5	165	0.82
	largemouth bass	7.5	83	0.15
	largemouth bass	6.5	58	0.4

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